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THE HELIUM CONTENT

OF THE

STAUNTON (ILL.) GAS FIELD.

BY

ROBERT HUGHES DOUGHERTY

THESIS

FOR THE

DEGREE OF BACHELOR OF SCIENCE

IN

CHEMISTRY

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February 1, 1920.

THIS IS TO CERTIFY THAT THE THESIS PREPARED UNDER MY SUPERVISION BY

ROBERT H. DOUGHERTY

ENTITLED THE HELIUM CONTENT OF THE NATURAL GAS FROM THE STAUNTON (ILL.) FIELD.

IS APPROVED BY ME AS FULFILLING THIS PART OF THE REQUIREMENTS FOR THE DEGREE OF BACHELOR OF SCIENCE IN CHEMISTRY

David F. McFarland
Instructor in Charge

APPROVED: W. A. Noyes

HEAD OF DEPARTMENT OF CHEMISTRY.

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THE HELIUM CONTENT OF THE NATURAL GAS FROM THE STAUNTON (ILL.) FIELD.

I. INTRODUCTION

The work described in this paper is a continuation of that begun by L. C. Maxwell in 1917 and which was carried still further by E. W. Guernsey in 1918. It was originally intended to conduct a survey of all the sources of natural gas in Illinois. This paper is concerned with the helium content of the gases from the Staunton field.

During the war the British and United States governments became interested in helium as a substitute for hydrogen for filling balloons, and under the stimulus of war time necessity the United States Bureau of Mines worked out a method by which they could produce helium in large quantities at a cost of ten cents per cubic foot. (1) Natural gas, containing a small per centage of helium, was taken from the wells, liquified by either the hinde of claude process, the helium pumped off and the liquified gas allowed to vaporize and pass back into the mains. Helium liquifies at about 4° absolute so naturally it still existed as a gas at the moderately low temperatures at which the other gases liquified.

Helium is an ideal gas for filling balloons. It is inert, non-inflammable, has 92% of the lifting power of hydrogen and diffuses through the balloon fabric at only one half the rate of hydrogen.

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(1) Chem. and Met. Eng. Vol.20, No. 3 Pages 104-114. Jour.Ind.& Eng. Chem.

Plants producing helium are still in operationiin Texas and it is desirable and probable that if sufficient helium can be produced it will replace hydrogen in balloons of the Zeppelin type. The use of helium reduces the fire hazard to a minimum, and would eliminate such accidents as that which occurred recently in Chicago when a Blimp caught fire causing the death of thirteen people. The present sources of helium do not furnish enough gas to replace hydrogen, and consequently any new sources are of interest.

II. METHOD USED IN THE DETERMINATION OF HELIUM.

The method of H. P. Cady and D. F. Mc Farland (J.A.C.S. V. 29,pp 1523) was used in making the determinations described in this paper. These authors found that only one of the natural gases they analysed did not contain helium in some amount. (1). They also found that the higher the nitrogen content the higher the helium content. In view of this fact, it was decided to investigate the gases in Illinois that contained the largest amounts of nitrogen. The work of . C. Maxwell showed that gas from the Staunton field contained more nitrogen than any of the Illinois gases, and it was decided to analyse the gases from that field first.

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(1). J.A.C.S.Vol. 29,p 1523

III Sampling

Samples of gas were taken in pressure tanks. Several old Prest-O-Lite tanks were cut in two, the packing removed and a hole bored in one end and fitted with a steel taper plug to insure a gas tight fit.-- they were then welded together and were ready for use. Before taking a sample the plug in the end of the tank was removed, the tank connected up to the well and the gas turned on so as to sweep all the air out of the tank. When this had been done the plug was screwed in tightly, and the full well pressure was turned into the tank. Before shipping the tanks were submerged in water to test for leaks.

IV PRELIMINARY ANALYSIS OF THE SAMPLES.

A modified Orsatt apparatus of the type adopted by the United States Bureau of Mines was used in analysing the samples. The procedure outlined in Dennis (1) was followed. Carbon dioxide was absorbed in sodium hydroxide, oxygen in alkaline pyrogallol, unsaturated hydrocarbons in bromine water and carbon monoxide in cuprous chloride. Methane was determined in a slow combustion pipette. The non absorbable and non combustible gases (nitrogen, helium, etc.) were determined by difference.

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(1) Dennis: Gas Analysis, pp 51-158

V THE DETERMINATION OF HELIUM.

The determination of helium is based upon the fact that cocoanut charcoal, when cooled by liquid air, will completely absorb all gases except helium neon and hydrogen. Helium and neon are scarcely absorbed at all and Cady and Mc Farland found that hydrogen is nearly completely absorbed. (1)

The apparatus for the determination of helium is illustrated diagramatically in figure (I). (A) is an aspirator calibrated in liters. The aspirator is connected directly to the sample tank, and when a sample is drawn into the aspirator the temperature, pressure, and humidity are determined at the same time so that the volume of gas, under standard conditions, is known. (B) is a bulb of one hundred c.c. capacity, surrounded by liquid air in a Dewar flask, in which the larger part of the easily condensable gases are liquified. This takes a great part of the work from the charcoal bulbs and enables one to use a large sample of gas. (C) and (D) are special Pyrex glass bulbs filled with cocoanut charcoal that has been prepared in a muffle at red heat. The Pyrex bulbs can be sealed on to the rest of the system with Bank of England sealing wax if pyrex tubing is not used throughout. Dr. Knipp, of the department of Physics, recommends this wax very highly for all vacuum work. (E) and (G) are two U tubes one of which is placed before and one after the Plücker tube (F).

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(1). J. A. C. S. V. 29, p 1526

(E) and (G) are so arranged that they can be placed in one Dewar flask. (E) traps water vapors, and tube (G) mercury vapors from the mecury pump (H). In this way mercury and water vapors are kept from interfering with the helium spectrum which is observed in the Plücker tube with a spectroscope (Not shown in the diagram. A spectroscope calibrated against a known specimen of helium is used. In this work helium was made by heating monazite sand and its spectrum observed in the spectroscope.) The high voltage for the Plücker tube is supplied by a 6 ampere Thordarsen spark coil which is equipped with a platinum point. (H) is a three fall Sprengel mercury pump which is made automatic by a device that returns the mercury from the basin (I) to the reservoir (O). A partial vacuum is created in (O) by two Chapman water pumps, and a mixture of mercury and air is pulled up the side arm (q). The amount of air admitted into the side arm (q) is controlled by a valve at (R). (P) is a burette that is used to measure the volume of gas pulled through the system by the Sprengel pump. (J) and (K) are one way stop-cocks. (L) is a two way stop-cock connecting with the bulb (B) and the oil pump (M).

Some difficulty was found in making the stop-cocks gas tight. This trouble was solved by surrounding the top of the stop-cock with mercury held in place by a piece of large rubber tubing which was slipped over the top of the stop-cocks.

Prior to making a run the system was exhausted to the limit of the oil pumps. While this was being done, the charcoal bulbs were heated quite strongly with a Bunsen burner to remove all gases that

might have been left in from a previous run. When the limit of the oil pumps was reached the heating was discontinued and the Sprengel pump was turned on. The system was pumped out until difficulty was experienced in passing a spark through the Plücker tube. When this stage was reached (B), (C), (D), (E) and (G) were immersed in liquid air and the vacuum became so high that a spark would scarcely pass.

A known volume of gas was then pulled into (B) from the aspirator (A), and held there for five minutes. (A) was cut off from (B) by a pinch cock else water would have been drawn over into (B). Stop cock (L) was then opened (K, J being closed) and the uncondensed gas passed into (C) where it was held five minutes. The liquid air around (B) was removed for an instant so that some of the liquified gas in (B) would boil over into (C). This done, (L) was closed. (K) was next opened and the gas passed into (D) where it was held for five more minutes. (J) was then opened and the gas (if any remained unabsorbed) was pulled through the Plücker tube (F) where the spectrum of the gas was examined. The spectrum of helium is characteristic and furnishes an excellent method for its identification. The gas collected in the burette (P) was then measured over water and the volume reduced to standard conditions. Then knowing how much gas was introduced into the system and how much passed through the percentage of helium in the sample could be calculated.

VI RESULTS OF THE ANALYSES AND CONCLUSION.

Five samples of gas from the Staunton field were examined. Sample No. I was taken from Superior Well number two, sample No.II from Hamp Woolridge Well number two, sample No. III from Dan Grove Well number one, sample No. IV from Hamp Woolridge Well number two, and sample V from Superior Well number one. Samples I and II were taken on March 22, 1919; samples III, IV, V were taken July 27,1919. The analyses on the first two samples were run July 20, some time after the samples were taken, while the analyses on samples III, IV, and V were run on August 7, 1919. The results of the analyses are given in the following table.

Table I.

Sample	1	2	3	4	5
CO_2	0.1	0.3	0.5	0.8	.2
O_2	0.2	0.2	0.2	0.6	.4
Unsaturated Hydro.	0.0	0.0	0.0	0.0	0.0
CO	0.0	0.0	0.0	0.0	0.0
CH_4	84.9	85.6	90.0	86.2	90.8
N_2	14.8	13.9	9.3	12.4	8.6
He	0.0	0.0	0.0	0.0	0.0

The Staunton field was opened up in 1915 and at that time the pressure in most of the wells was around 135 lbs. The gas sand lay about 450 feet below the surface. (1) In the spring of 1919 when the above samples were taken the pressure had dropped to 6 lbs. and later reports are that the wells are about exhausted.

No helium was found in any one of the five samples, not even enough to notice in a spectroscope and there is evidently none in the Staunton gas. It seems safe to assume that this field contains no helium, and if it did it is so nearly played out that it would be of no commercial importance.

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(1) U. S. Geol. Survey, Bull. 33, p 81.

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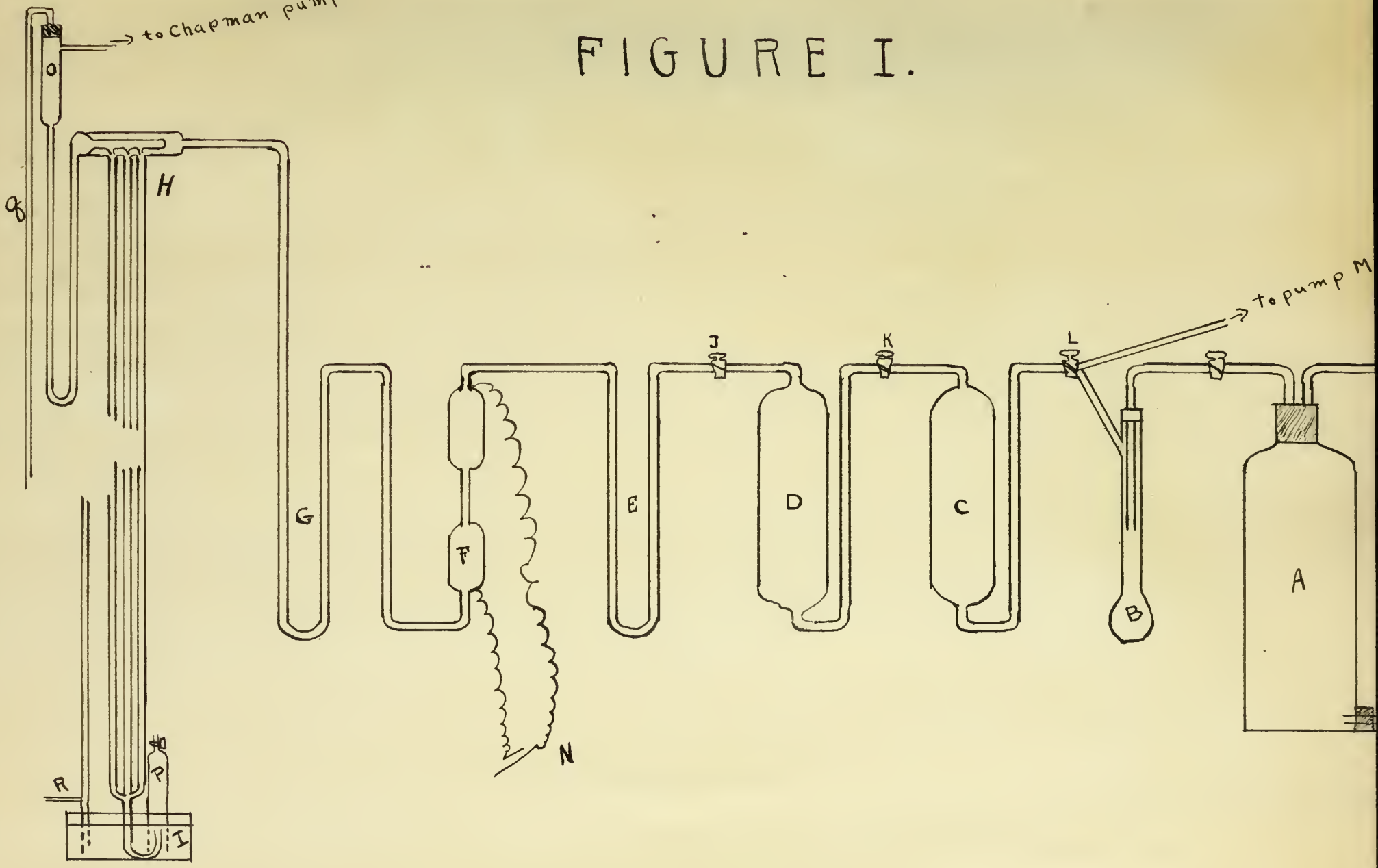
FIGURE I.



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